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EOLIAN LOESS.

J. E. Todd.

OF LATE YEARS numerous writers have supported the view that the mass of the yellow loam of the Missouri and Mississippi river valleys is of eolian origin. Some textbooks define loess as an eolian deposit without qualification. While the writer cannot harmonize this extreme view with the facts known to him, he would enumerate several cases which are unquestionably the work of the wind.

He would first call attention to the conditions productive of sand dunes in certain localities; secondly, show that the accumulation of dust is often to be explained in similar ways; thirdly, note one locality which can be explained in no other way; and fourthly, explain the *modus operandi* of such deposits generally.

1. South of the Platte river, near Kearney, Neb., is a strip of conspicuous dunes crowning the bluffs and rising above the upland level further south. The sand apparently has been raised by the northwest wind from the river channel just north. Moreover, the greater accumulation there may be accounted for by the fact that the river above this point has a southeasterly course for several miles and there changes to due east.

2. Another cluster of dunes, rising above the general level around, occurs east of West Point, Neb., where the Elkhorn changes sharply from a long southeasterly course to a southerly. In both of these cases the northwest wind is considered particularly instrumental, because it prevails at a time when the river is low, the bars extensively uncovered and the vegetation elsewhere scanty.

3. We now call attention to accumulations of finer material —in other words, loess—in analogous situations along the Missouri river. In these cases there is very little sand available, and only of a fine grain, and the bluffs are much higher than those already considered. The general course of the river is south-southeast from Sioux City to northern Missouri. The bottom lands on the east of the river are in places very wide. These occur where soft rocks lie at the level of the river. On the contrary, where harder strata at that level have

resisted the erosion of the stream, the valley is narrow and as a consequence high bluffs rise conspicuously on the east side of the valley just south of the wide areas first mentioned. Because of the relations described above, such projections of the east bluffs are apt to grow in height till they rise considerably above the upland level further east.

A typical case of this sort is found four or five miles south of Pacific Junction, in southwestern Mills county, Iowa.

Another is north of Council Bluffs and south of Crescent City, and another lies east of the Little Sioux, in southern Monona county. The gathering ground for this last was a bottom land twelve to fifteen miles wide; consequently the bluffs are unusually high.

4. A somewhat different case is found in southern Plymouth county, east of the Big Sioux river, and of a broad bottom land between that stream and the Missouri further west, and of the bend in the latter stream, where it changes from an easterly direction to the south-southeast.

Dr. H. F. Bain, in his report on Plymouth county, called attention to the peculiarities of this area. (Iowa Geol. Rept., vol. viii, p. 322.) The region shows the divides rising 250 to 300 above the streams and 60 to 100 above the upland level on the east and north. This extra height seems to be due to recent deposition over the whole surface. The valleys are so narrowed that the streams can barely keep their courses. The boundary on the northeast is a line running from Westfield to Millinerville. He thinks it may be plausibly referred to the sweeping of dust from the broad flood plain west by the wind. The writer approved that view in his report on part of the same area in the Elk Point Folio, of the U. S. Geological Survey.

5. Crowning the highlands in northern Nebraska, which constitute the divide a few miles south of the Missouri river, are high ridges of loess, beginning as conspicuous headlands at the northwest ends, and running southeast and widening till they coalesce in a general sheet. It may be that they are remnants of an area similar to that just described, which formerly accumulated south of the Missouri and lower lands of South Dakota, as the former did on the east. The gathering ground for that older deposit was the surface succeeding the Kansan stage of the ice age, while that for the Plymouth county area was succeeding the Wisconsin stage.

6. In the cases considered thus far we have no carefully prepared topographic maps to give quantitative expression to our facts, but recently some excellent maps have been made of limited areas in southeastern Nebraska. From these we glean a few facts pertinent to our subject. In the northeast one-fourth, section 8, township 3 north, range 17 east, Richardson county, Nebraska, on the Falls City topographic sheet is a sharp peak rising 1,260 feet above the sea and 380 above the river less than half a mile away. It is only 20 or 30 feet higher than several others near by and scattered along the very verge of the upland, and just south of an east-southeasterly course of the Missouri and south of a wide flood plain of that stream stretching north-northwest many miles. A remarkable feature of this case is that upland level to the southwest rarely rises above 1,150 feet. We may add that the upland level on the east and west sides of the river further north is about the same, viz., 1,150 feet. Here again, therefore, we find another example of unusual altitude attained by accumulation of dust from an adjacent river valley, this time on the west side of the river, though still to the southwest of the gathering area.

7. Quite a different accumulation of loesslike silt was hastily observed by the writer in the southern Black Hills, not far from Chilson station, in Fall River county, South Dakota. There great dust drifts, 20 to 30 feet high, lie like great snowdrifts. A railroad cut through one showed its homogeneous and structureless nature, and buff color, in all these respects resembling closely the loess along the Missouri river.

8. The last case we record is at Thermopolis, Wyo. It is a sheet of reddish loam 15 to 25 feet thick, lying on a broad, flat deposit of travertine many feet in thickness and rising 400 feet above the Big Horn river, close by. Evidently the travertine was the deposit of the hot springs which are still continuing such work at much lower levels. The upper deposit is much the older, made before the drainage had been lowered. The north side of the travertine-capped ridge is quite abrupt. No theory for depositing the fine loam by water can be reasonably formulated. It is clearly another case of raising of dust from lower levels up a steep slope and spreading it on the comparatively flat summit. The loam has a distinctly reddish tint, corresponding to the "Red Beds" which comprise much of the surface on the north.

THEORETICAL EXPLANATION. The seventh case may be sufficiently accounted for by conceiving it to be quite analogous to the formation of common snowdrifts. In the other cases there is the difficulty of raising the material to greater height and spreading it out as a thin sheet. The conditions apparently essential to these are the following:

(1) Broad, bare areas of sand bars or mud flats, where the wind has free sweep at them.

(2) A precipitous slope lying athwart the course of the wind, steep enough to turn the stream of air sharply upward, with velocity sufficient to prevent any wind striking the top of the bluff horizontally; in fact, so as to produce a still area with a partial vacuum there. Such areas are easily found on flat-topped buttes, or on flat-roofed buildings on windy days. I have frequently found a difference of .02 inch air pressure, on the same level, between the verge of the level in the wind and back a few feet in the still air.

(3) A flat area of some extent, covered with vegetation of some sort, which will prevent the dust which settles there from being blown away by the gentler breezes which will strike the surface horizontally, and from the wash of the rains. Grass is probably best suited to do this.

Under such conditions the wind gathers the sand and dust from the bars on windy days. They may be often seen rising like smoke along such streams as the Missouri. When the air is turned upward by the steep bluff, the sand is mostly arrested at lower levels. The dust goes on, and may be augmented by more wrenched from the side of the bluff where the friction is great.

After the wind regains its horizontal direction after its upward turn, the dust will gradually and quite evenly settle out of it into the still space below, where it is apt to rest protected by the vegetation from the rains and horizontal breezes, until it is undermined and carried away by ravines cutting back from the adjacent slopes.

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